FRAMEWORKS FOR VOCATIONAL-TECHNICAL PROGRAMS REVISED IN 2009-2010

SECONDARY EXECUTIVE SUMMARY

2010

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Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
  - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
  - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.

- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.
- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

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DIESEL SERVICE TECHNICIAN

Pathway Description

Diesel Service Technician is a pathway for students in the Transportation career cluster. This program is designed for students who wish to diagnose and repair the systems and components related to diesel engines. The program emphasizes the techniques and tools used in servicing diesel systems and components. Both theoretical learning and activity-based learning are provided for students who wish to develop and enhance their competencies and skills. The course focuses on the basic areas of diesel engine components, electrical and electronic systems, and hydraulics. Exposure to state-of-the-art equipment is given through advice by experts from industry. The comprehensive project component provides practical experience toward developing a portfolio of work.

The program is aligned with the NATEF 2007 Medium/Heavy Truck program standards, which were retrieved August 1, 2009, from http://www.natef.org.

Industry Certification

The Diesel Service Technician pathway was written to incorporate the **National Automotive Technicians Education Foundation (NATEF)** learning objectives, content, and hours. Any student who successfully completes this program will be eligible to apply to obtain the ASE exams. ASE requires 2 years of employment before certificates are issued. Students receive 1 year of credit for completion of the secondary program. Students who take certifications before the 2-year requirement is met will be granted certifications after they complete 1 year of diesel service employment. NATEF is a national certification recognized throughout the transportation service industry. Each district should implement a maximum student number due to the size of each lab.

Articulation

This program was designed to articulate to postsecondary programs in Diesel Equipment Technology.

High School Program	Community College Program	Community College Course
Diesel Service Technician	Diesel Equipment Technology	DET 1114 - Fundamentals of Equipment

Assessment

Students will be assessed using the Diesel Service Technician MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://redesign.rcu.msstate.edu/curriculum/. If there are questions regarding assessment of this program, please contact the Transportation instructional design specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be able to experience success in the Diesel Service Technician program, the following student prerequisites are in place:

1. C or higher in English (the previous year)
2. C or higher in Math (last course taken or the instructor can specify the math)
3. Instructor Approval and TABE Reading Score (eighth grade or higher)

or

1. TABE Reading Score (eighth grade or higher)
2. Instructor Approval

or

1. Instructor Approval

Proposed Applied Academic Credit

Applied Mathematics content from the curriculum was aligned to the 2007 Mississippi Mathematics Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn one Applied Mathematics Credit that can be used for graduation requirements.

The applied academic credit has ***not*** been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

A 968 educator license is required to teach the Diesel Service Technician pathway. The requirements for the 968 licensure endorsement are listed below:

1. Applicant must have earned a 2-year college degree (associate degree) or higher from an accredited institution of higher education.
2. Applicant must have 2 years of documented diesel service experience.
3. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
4. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
5. Applicant must hold ASE certificates in Medium Heavy Duty Truck (test Diesel T2), Electrical/Electronics (Test T6), and Preventative Maintenance (Test T8).
6. Applicant must successfully complete an approved computer literacy certification exam.
7. Applicant must successfully complete a certification for an online learning workshop, module, or course that is approved by the Mississippi Department of Education.
8. Applicant must successfully complete a Diesel Service Technician certification workshop, module, or course that is approved by the Mississippi Department of Education.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at http://redesign.rcu.msstate.edu. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outline

This curriculum framework allows multiple options for local school districts to implement based on the local needs of industry and students. The first option groups units into four one-Carnegie-unit courses. The second option groups units into a 2-year, four-Carnegie-unit program. An in-depth discussion of each option is listed in the following material.

Option 1 – Four One-Carnegie-Unit Courses

This Diesel Service Technician Pathway option emphasizes industry-based content with time being allocated between lecture and lab activities. The content is aligned with National Institute for Automotive Service Excellence (ASE) standards to ensure that programs can be recommended for certification by National Automotive Technicians Educational Foundation (NATEF) learning objectives and content.

The Diesel Service Technician Pathway (four Carnegie units total) is a program that will prepare students for the diesel service industry. The content is divided into four one-credit courses. These courses are to be taken sequentially. Safety is an integral part of every course and activity. A student must complete all four courses to be a completer and to receive the one mathematics credit.

- Safety will be reinforced and tested at the beginning of each year and throughout the content.
- Students are not to enroll into multiple courses at the same time.
- Courses cannot be taken out of the order unless the instructor approves. Foundation knowledge in each course must be mastered to move to the next unit.
- Students must complete diesel courses with a score of 80/C or higher in class work to advance to the next level.

Course Description: Fundamentals of Diesel Systems and Components
Fundamentals of Diesel Systems and Components contains information on safety, tool identification and use, employee information, estimating, service specification and service information, measurement, and personal and business finance.

Course Description: Electrical/Electronic Systems
The Electrical/Electronic Systems course contains electrical/electronic system theory, battery systems, starting systems, charging systems, concepts of gauges, warning devices, driver information systems, horn system, wiper/washer system, and accessories system diagnostic repair.

Course Description: Diesel Engine Performance
The Diesel Engine Performance course contains information on safety, employability skills, advanced diesel service, diesel engine components and theory of operation, concepts of computerized engine control systems, and ignition systems.

Course Description: Auxiliary Components and Systems
The Auxiliary Components and Systems course contains information and skills relating to hydraulics, Introductory Truck Brake Systems, Introductory Agriculture/Construction Power Train and Components, and Introductory Welding and Cutting.

Fundamentals of Diesel Systems and Components (One Carnegie Unit) - Course Code: 997202

Unit		Title	Hours
1		Fundamentals of Diesel Systems and Components	25
2		Diesel Systems, Theories, and Components	115
			140

Electrical/Electronic Systems (One Carnegie Unit) - Course Code: 997203

Unit		Title	Hours
3		Electrical/Electronic Systems	140
			140

Diesel Engine Performance (One Carnegie Unit) - Course Code: 997204

Unit		Title	Hours
4		Preventive Maintenance and Inspection	70
5		Advanced Diesel Engine Performance	70
			140

Auxiliary Components and Systems (One Carnegie Unit) - Course Code: 997205

Unit		Title	Hours
6		Auxiliary Components	
		• Hydraulic Systems, Theories, and Components	70
		• Introductory Truck Brake Systems and S/S Components	15
		• Introductory Agriculture /Construction Power Train and Components	15
		• Introductory Welding and Cutting	40
			140

Option 2 – Two Two-Carnegie-Unit Courses

This Diesel Service Technician Pathway option emphasizes industry-based content with time being allocated between lecture and lab activities. The content is aligned with National Institute for Automotive Service Excellence (ASE) standards to ensure that programs can be recommended for certification by National Automotive Technicians Educational Foundation (NATEF) learning objectives and content.

The content is divided into two courses. Safety is an integral part of every course and activity. A student must complete both courses to be a completer and to receive the one mathematics credit.

Course Description: Diesel Service Technician I Fundamentals of Diesel Systems and Components contains information on safety, tool identification and use, employee information, estimating, service specification and service information, measurement, and personal and business finance. It also contains Electrical/Electronic Systems content: electrical/electronic system theory, battery systems, starting systems, charging systems, concepts of gauges, warning devices, driver information systems, horn system, wiper/washer system, and accessories system diagnostic repair.

Course Description: Diesel Service Technician II The Diesel Engine Performance course contains information on safety, employability skills, advanced diesel service, diesel engine components and theory of operation, concepts of computerized engine control systems, and ignition systems. It also contains Auxiliary Components and Systems content: information and skills relating to hydraulics, Introductory Truck Brake Systems, Introductory Agriculture/Construction Power Train and Components, and Introductory Welding and Cutting.

Diesel Service Technician I (Two Carnegie Units) - Course Code: 997200

Unit		Title	Hours
1		Fundamentals of Diesel Systems and Components	25
2		Diesel Systems, Theories, and Components	115
3		Electrical/Electronic Systems	140
			280

Diesel Service Technician II (Two Carnegie Units) - Course Code: 997201

Unit		Title	Hours
4		Preventive Maintenance and Inspection	70
5		Advanced Diesel Engine Performance	70
6		Auxiliary Components	140
			280

- Scheduling and operating more than one course in the same classroom/laboratory with the same teacher is not allowed.
- Students must complete the first year with a score of 80/C or higher in class work to advance to the next level.

Pathway Name: Diesel Service Technician
CIP Code: 47.0605

Fundamentals of Diesel Service

1. Introduce, describe, and distinguish local program and vocational/career–technical center policies and procedures.
   a. Describe local program and vocational/career–technical center policies and procedures including dress code, attendance, academic requirements, discipline, and the school technology acceptable use policy and transportation regulations.
   b. Compare and contrast local program policies, procedures, and expectations to industry policies, procedures, and expectations.
2. Introduce, describe, and express employment opportunities and responsibilities of the diesel service industry.
   a. Introduce concepts associated with the diesel service industry; describe employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements.
   b. Describe basic employee responsibilities and how to communicate effectively in on-the-job situations. Identify and apply the practices that affect employer and employee decision making as it relates to identifying and applying appropriate algebraic formulas to personal finance situations, linear programming to business decisions, and algebraic formulas to personal and business investments.
   c. Discuss the history of the diesel service industry to include materials, terminology, and techniques.
   d. Research and report the computerized systems used by technicians in the diesel service industry.
3. Investigate and replicate leadership skills and personal development.
   a. Demonstrate effective team-building and leadership skills.
   b. Model appropriate work ethics.
   c. Describe basic employee responsibilities.
   d. Design a resume and letter of application, and complete a job application.
   e. Demonstrate an understanding of the impact of consumer credit (advantages and disadvantages of installment loans, applying algebraic formulas to consumer credit).
   f. Design, collect, and apply information for planning a trip.
4. Model general safety rules for working in a shop/lab and an industry setting.
   a. Explain the importance of following all safety rules and policies (report all on-the-job injuries and accidents), evacuation policy, substance abuse policy, and procedures when working near pressurized or high temperature, and explain electrical hazards and the action to take when an electrical shock occurs when performing diesel service operations (personal protective equipment, procedures for lifting heavy objects, and MSDS).

   b. Explain the process by which fires start, fire prevention of various flammable liquids, the classes of fire, and the types of extinguishers.
   c. Identify and demonstrate the safe and proper use of common hand tools.
5. Interpret and apply service specifications and information.
   a. Locate and interpret service specifications and information, using both print and computerized service information references and vehicle and major component identification numbers (VIN, certification, and calibration labels).
   b. Interpret and apply information to a specific job on a specific vehicle.
6. Demonstrate measurement practices used in the diesel service industry.
   a. Measure the length of an object using a rule to the nearest 1/16 in. and 1 mm.
   b. Identify the different types of bolts (grade, diameter, length, and thread pitch), nuts, and washers, and describe their appropriate uses.
7. Manage personal and business finances to include aspects of employer–employee decision making and consumer credit.
   a. Design, analyze, and develop business finance concepts and skills.

Diesel Systems, Theories, and Components

1. Inspect, analyze, and perform service to diesel engine systems and components.
   a. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, and causes and corrections; determine needed repairs.
   b. Identify and inspect diesel engine components and parts.
   c. Analyze and diagnose engine noises according to manufacturer's specifications.
2. Analyze, diagnose, and perform skills related to cylinder head and valve train.
   a. Diagnose cylinder head components.
   b. Diagnose and perform procedures related to the valve trains.
   c. Inspect and repair various diesel engine components.
3. Inspect, determine correct procedures, and perform the repair technique(s) related to an engine block.
   a. Diagnose various block components and the replacement/repair procedures.
   b. Identify and discuss factors related to block component failure.
   c. Identify and discuss factors related to block system failure.

Electrical/Electronic Systems

1. Identify, analyze, and perform repair procedures to general electrical systems.
   a. Identify, analyze, and perform repair procedures to electrical/electronic systems and components.
   b. Analyze, evaluate, recommend, and perform necessary repairs to the components and systems related to the battery.
   c. Evaluate, recommend, and perform repair procedures as they relate to the starting system.
   d. Diagnose and repair charging system.

e. Explore, analyze, and recommend proper repair procedures as they relate to lighting systems.
f. Test and evaluate gauges and warning devices.
g. Identify, evaluate, and recommend replacement or repair procedures of related electrical systems.

Preventive Maintenance

1. Identify, evaluate, and repair engine systems and their components.
   a. Identify and inspect, determine necessary action, and perform the procedure as it relates to diagnostic and repair operations to engine components.
   b. Identify, diagnose, recommend, and/or perform the necessary repair action as it relates to the fuel system.
   c. Identify, practice, and evaluate air induction and exhaust systems.
   d. Identify, practice, and evaluate cooling and lubrication systems.
2. Inspect, diagnose, and recommend repair procedures for components and systems related to the cab and hood.
   a. Identify and inspect; determine necessary procedures as they relate to the cab and hood.
   b. Identify, diagnose, and determine necessary procedures to electrical/electronic systems and components.

Advanced Diesel Engine Performance

1. Identify, inspect, determine the action, and perform the procedure as it pertains to lubrication systems, cooling systems, air induction, and exhaust systems.
   a. Safety precautions, regulations, and guidelines for diesel engines.
   b. Analyze and demonstrate information for lubrication and cooling systems.
2. Determine failure cause(s), perform repair procedure, and evaluate procedure related to fuel systems and electronic fuel management systems.
   a. Diagnose, inspect, practice, and determine necessary procedures for fuel management system maintenance and repair procedures.
   b. Inspect, analyze, and perform repairs related to engine brakes.

Auxiliary Components and Systems

1. Explore and analyze hydraulic systems, theories, and components.
   a. Inspect, indentify, and evaluate general hydraulic system control valves; actuators; and hoses, fittings, connections, pumps and filtration/reservoirs (tanks).
2. Identify and inspect truck brake systems and steering/suspension components.
   a. Indentify, inspect, and analyze truck brake systems and steering/suspension components.
3. Identify and evaluate agriculture/construction power train and components.

   a. Inspect, identify, and diagnose agriculture/ construction power trains and components.
4. Indentify, perform and analyze welding and cutting techniques.
   a. Identify, analyze, and perform operations pertaining to welding.

EARLY CHILDHOOD EDUCATION

Pathway Description

Early Childhood Education is a pathway in the Human Science, Art, and Humanities career cluster. This is a two year high school program (offering 4 Carnegie units of credit), which includes classroom and hands-on experiences that help to prepare students for employment or continuing education in the early childhood education field. In the course of study, emphasis is placed on students' personal and professional preparation for careers or education in the field, history and trends of early childhood education, children's health and safety, child development, and child guidance and observation. In additional topics covered, emphasis is placed on career and professional development, characteristics of high quality early childhood centers, management and administration in quality child care programs, and the learning environment. Membership is encouraged in the student organization, FCCLA (Family, Career, and Community Leaders of America), which provides activities for leadership and the application of competencies through participating in competitive events. Skills developed through the course of study assist students in meeting requirements for the CDA (Child Development Associate credential).

Industry Certification

This curriculum is based on state and national standards, CDA (Child Development Associate) standards, NAEYC (National Association for the Education of Young Children) standards, as well as 21st century workforce skills. The curriculum combines effective classroom instruction with hands-on training or internships in local child care sites. Due to the growing information-technology age in education, the National Educational Technology Standards for Students are incorporated into the curriculum.

Articulation

The following articulation plan is in place for the Early Childhood Education Pathway.

High School Program	Community College Program	Community College Course
Early Childhood Education	Early Childhood Education Technology	Early Childhood Profession (CDT 1113) -student must pass MS-CPAS2

Assessment

Students will be assessed using the Engineering MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://redesign.rcu.msstate.edu/curriculum/. If there are questions regarding assessment of this program, please contact the STEM instructional design specialist at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

Upon entering the course:

1. "C" averages in Biology (if applicable) and English from the previous school year
2. Application and/or Interview process

Third and Fourth Carnegie Unit:

1. "C" average or better grade in the first two Carnegie Units

Proposed Applied Academic Credit

Applied Health content from the curriculum was aligned to the 2006 Mississippi Comprehensive Health Framework or the 2008 Family and Individual Health Framework (Family and Consumer Science course). It is proposed that upon the completion of this program, students will earn 1/2 comprehensive or family health credit that can be used for graduation requirements.

The applied academic credit has ***not*** been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

The 970 licensure endorsement is required for instructors in the Early Childhood Education pathway. The requirements for the 970 licensure endorsement are the following:

1. Currently valid Mississippi Educator License with endorsement in #321-Vocational Home Economics/Family and Consumer Sciences or #322-Home Economics/Family and Consumer Sciences.
2. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
3. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
4. Applicant must successfully complete the Red Cross Instructor certification.
5. Applicant must successfully complete an MDE-approved computer literacy certification exam.
6. Applicant must successfully complete a certification for an online learning workshop, module, or course that is approved by the MDE.
7. Applicant must successfully complete an Early Childhood certification workshop, module, or course that is approved by the MDE.

Note: If the applicant meets all requirements listed above, that applicant will be issued a 970 endorsement-a 5-year license. If the applicant does not meet all requirements, the applicant will be issued a 3-year endorsement (license), and all requirements stated above must be satisfied prior to the ending date of that license.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at http://redesign.rcu.msstate.edu. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outline

This curriculum framework is divided into four one-Carnegie-unit courses as outlined below. The first two courses are comprised of units from Early Childhood Education year 1. The last two courses are comprised of units from Early Childhood Education year 2.

Option 1 – Four One-Carnegie-Unit Courses

Course Description: Fundamentals and Stages of Child Development

This course is an introduction to personal and professional preparation and careers in the field of early childhood education. Other topics covered are the history and trends of education. The majority of hours in this course are spent on child development, ranging from birth throughout the adolescent years. Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will continue to develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Course Description: Children's Health, Safety, and Guidance

Much of this course relates to topics which include protecting children's health and safety. Students are introduced to MSDH Guidelines and Regulations Governing Child Care Facilities. Other topics covered are related to the importance of observing and assessing children. Methods of child guidance techniques are also introduced in this course. Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will continue to develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Course Description: The Learning Environment

This course is a continuation of year one in regards to students continuing to develop educational, career, and professional plans in the area of early childhood. The major topic of this course includes curriculum planning and scheduling in an early childhood program. Students will develop age appropriate activities and create lesson plans that encompass all areas of child development. Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will continue to develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Course Description: Management of a Quality Child Care Program

This course includes topics related to state licensing requirements for child care facilities, management principles as a center director (including responsibilities regarding management of personnel, the facility's physical indoor and outdoor space, inventory, record-keeping, accreditation, parental involvement, marketing, budgeting, and maintaining a healthy, effective learning environment). Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will continue to develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Fundamentals and Stages of Child Development (One Carnegie Unit) - Course Code: 996202

Unit		Title	Hours
1		Orientation, Personal and Professional Preparation	20
2		Child Development: Infants-Middle Childhood Years	80
3		History and Trends of Early Childhood Education	20
			120

Children's Health, Safety, and Guidance (One Carnegie Unit) - Course Code: 996203

Unit		Title	Hours
4		Health and Safety	80
5		Observation, Assessment, and Guidance	40
			120

The Learning Environment (One Carnegie Unit) - Course Code: 996204

Unit		Title	Hours
6		Career Development and Professionalism	40
7		The Learning Environment	80
			120

Management of a Quality Child Care Program (One Carnegie Unit) - Course Code: 996205

Unit		Title	Hours
8		Characteristics of Quality Child Care Programs	40
9		Management and Administration	80
			120

Option 2 – Two Two-Carnegie-Unit Courses

Course Description: Early Childhood Education I

This course begins with an introduction to personal and professional preparation for continued education, training, and careers in early childhood. Major topics of study in this course are stages of child development, ranging from birth through age twelve, and children's health and safety. Students are introduced to MSDH Guidelines and Regulations Governing Child Care Facilities. Other topics covered are related to the importance of observing and assessing children. Methods of child guidance techniques are also introduced in this course. Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Course Description: Early Childhood Education II

This course focuses on curriculum planning and the development of age appropriate activities and lesson plans that encompass all areas of child development, and administration and management techniques needed in order to operate a successful, quality child care facility. Other major topics covered in this course are related to state licensing requirements for child care facilities, management principles as a center director (including responsibilities regarding management of personnel, the facility's physical indoor and outdoor space, inventory, record-

keeping, accreditation, parental involvement, marketing, budgeting, and maintaining a healthy, effective learning environment). Students will continue to develop educational, career, and professional plans in the area of early childhood. Participation in FCCLA (Family, Career, and Community Leaders of America) is ongoing. Students will participate in field experience, internships, and job-shadowing. Students will continue to develop skills toward meeting requirements for the CDA (Child Development Associate) credential.

Early Childhood Education I (Two Carnegie Units) - Course Code: 996200

Unit		Title	Hours
1		Orientation, Personal and Professional Preparation	20
2		Child Development: Infants-Middle Childhood Years	80
3		History and Trends of Early Childhood Education	20
4		Health and Safety	80
5		Observation, Assessment, and Guidance	40
			240

Early Childhood Education II (Two Carnegie Units) - Course Code: 996201

Unit		Title	Hours
6		Career Development and Professionalism	40
7		The Learning Environment	80
8		Characteristics of Quality Child Care Programs	40
9		Management and Administration	80
			240

Pathway Name: Early Childhood Education
CIP Code: 19.0709

Orientation, Personal, and Professional Preparation

1. Examine and research educational, occupational, and leadership opportunities in Early Childhood.
   a. Identify career trends, workplace options, and opportunities that are available in early childhood.
   b. Research education and training requirements for various career paths in early childhood education.
   c. Develop career and educational plans.
   d. Conduct orientation and demonstrate safety, including proper operating procedures of lab equipment.
   e. Identify leadership opportunities in the school and community through encouraging students' membership and participation in FCCLA.
   f. Create Blackboard log-ins and passwords, and navigate throughout the RCU Blackboard site to locate the Early Childhood site for this particular class and become familiar with its use.
2. Analyze knowledge, skills, and dispositions needed to work in the teaching profession.
   a. Investigate the personal characteristics, roles, and functions of individuals engaged in early childhood education and services.
   b. Locate information in the Mississippi State Department of Health publication, Regulations Governing Licensure of Child Care Facilities, and understand requirements for students, volunteers, and caregiver assistants, regarding fingerprinting and background checks.

Child Development: Infants-Middle Childhood

1. Examine the physical, cognitive, social, and emotional development of infants from birth to 1 year of age.
   a. Explore brain development from birth to 1 year of age.
   b. Describe characteristics of physical development during the first year of life.
   c. Identify activities to encourage physical development from birth to one year of age.
   d. List cognitive skills that infants acquire from birth to 1 year of age.
   e. Examine social development during the first year of life.
   f. Explore Erikson's Psychosocial Theory of Human Development as related to infancy.
   g. Determine activities to encourage social development from birth to 1 year of age.
   h. Describe emotional development during the first year of life.
   i. Determine activities to encourage emotional development from birth to 1 year of age.
   j. Select activities, toys, and equipment to promote development from birth to 1 year of age.
2. Examine the physical, cognitive, social, and emotional characteristics of toddlers from 1 to 3 years of age.
   a. Describe characteristics of physical development from 1 to 3 years of age.
   b. List cognitive skills that toddlers acquire from 1 to 3 years of age.

c. Research Piaget's Theory of Cognitive Development.
d. Explore Erikson's Psychosocial Theory of Human Development as related to toddlers.
e. Investigate social development from 1 to 3 years of age.
f. Describe emotional development from 1 to 3 years of age.
g. Identify specific behaviors exhibited by toddlers to include but not limited to biting, temper tantrums, potty training, hitting, playing, eating, and sharing.
h. Select activities, toys, and equipment to promote all areas of development from 1 to 3 years of age.

3. Examine the physical, cognitive, social, and emotional characteristics of preschoolers from 3 to 5 years of age.
   a. Describe characteristics of physical development from 3 to 5 years of age.
   b. Develop activities to encourage physical development from 3 to 5 years of age.
   c. List cognitive skills that preschoolers acquire from 3 to 5 years of age.
   d. Explore language acquisition/development and the use of phonological awareness in teaching literacy to preschoolers.
   e. Compile activities to encourage language development in preschoolers.
   f. Research the cognitive stage according to Piaget's Theory of Cognitive Development.
   g. Explore Erikson's Psychosocial Theory of Human Development and Maslow's Hierarchy of Needs.
   h. Examine social development from 3 to 5 years of age.
   i. Develop activities to encourage social and emotional development from 3 to 5 years of age.
   j. Investigate emotional development from 3 to 5 years of age.
   k. Select toys and equipment to promote all areas of development from 3 to 5 years of age.
4. Examine the physical, cognitive, social, and emotional characteristics of children from age 6 through adolescence.
   a. Describe characteristics of physical, cognitive, social, and emotional development from age 6 through adolescence.
   b. Develop activities to encourage physical, cognitive, social, and emotional development from age 6 through adolescence.
   c. Explain moral development during this age range.
5. Discover inclusion and techniques to meet the developmental needs of special needs and culturally diverse children.
   a. Define the Individuals with Disabilities Education Act (IDEA).
   b. Examine an Individualized Education Plan (IEP).
   c. Research types of physical, cognitive, and behavioral disabilities (including but not limited to hearing, speech, language, vision, and mental or emotional disorders).
   d. Describe how the Americans with Disabilities Act affects children, parents, and employees.
   e. Investigate accommodations for children with special needs.

History and Trends of Early Childhood Education

1. Understand the history and evolution of early childhood education.
   a. Recognize the contributions of leaders and theorists throughout the history of early childhood education. (Suggested Jean-Jacques Rousseau, Johann Pestalozzi, Friedrich Froebel, Sigmund Freud, John Dewey, Maria Montessori, Elizabeth Palmer Peabody, Patty Smith Hill, Eric Erikson, Jean Piaget, B.F. Skinner, Lev Vygotsky, and/or Howard Gardner)
   b. Determine historical events that have influenced early childhood programs and initiatives throughout history in America.
2. Examine programs, initiatives, and accreditations that influenced early childhood education.
   a. Summarize the contributions of Head Start, Smart Start, and No Child Left Behind.
   b. Probe factors of the National Association for the Education of Young Children (NAEYC) accreditation.
   c. Outline requirements for obtaining the Child Development Associate (CDA) credential.
   d. Cite goals of the Mississippi Child Care Quality Step Program.
3. Recognize social and societal trends of early childhood education.
   a. Describe types of child care, including but not limited to parent cooperatives, lab schools, public and private center based programs, family child care, in home child care, nanny, au pair, and so forth.
   b. Determine trends in society that have led to a growing need for child care services.

Health and Safety

1. Explain the responsibilities of caregivers for protecting children's health and safety.
   a. Demonstrate proper sanitation practices of caregivers according to the MSDH regulation guidelines (with emphasis on hand washing, diapering, and feeding).
   b. Demonstrate the procedures for proper cleaning and sanitizing of equipment and facilities according to the MSDH regulation guidelines.
   c. Investigate responsibilities of caregivers for safety accordance with the MSDH guidelines including but not limited to topics such as adult to child ratio, food safety precautions, handling emergencies, universal precautions, safety hazards, equipment specifications, and so forth.
   d. Demonstrate appropriate responses to emergency situations to include fire drills, hurricane drills/evacuation, tornado drills, lock-down emergencies, and natural disasters.
   e. Complete and obtain the American Red Cross Certification in First Aid and Infant and Child CPR. (Adult CPR is optional.)
2. Recognize factors contributing to children's physical health.
   a. Research and identify childhood diseases, including signs and symptoms, incubation periods, and preventative measures.
   b. Know types of immunizations that Mississippi requires for enrollment in a child care facility and kindergarten.
   c. Cite the recommended time periods for indoor and outdoor play, exercise, and napping, according to the MSDH regulation guidelines throughout the early childhood years.

   d. Relate the importance of good nutrition and exercise for increased overall health in children and adults.
3. Describe factors contributing to children's mental and emotional health.
   a. Examine the impact of stress and its relation to the emotional well-being of children to include divorce, separation, remarriage, blended families, illness, death, and natural disasters.
   b. Create a list of children's literature that can be used as bibliotherapy tools.
   c. Investigate types of child abuse, prevention, and the reporting process.
   d. Identify methods and sources to help children and families cope with stress factors such as handling negativism, thumb-sucking, fear, biting, tattling, body exploration, and inappropriate behaviors.
   e. Demonstrate ways to promote children's self-esteem, trust, and emotional well-being.

Observation, Assessment, and Guidance

1. Investigate the importance of observing and assessing children in a child care setting.
   a. Identify the types of observation tools utilized in a child care setting (including but not limited to checklists, anecdotal records, rating scales, participation charts, samples of children's work, portfolios, photographs, videotapes, etc.).
   b. Determine the importance of assessments, both initial and ongoing assessments.
   c. Explore the assessment tools found in the Mississippi Early Learning Guidelines publication.
2. Identify goals of effective guidance.
   a. Explore positive child guidance methods and positive classroom management techniques.
   b. Describe principles of direct and indirect guidance.
   c. Demonstrate positive classroom management and guidance skills (ex. Giving I-messages, praising, affirming, prompting, persuading, suggesting, redirecting, ignoring, modeling, listening, encouraging, warning, use of time-out, rules, and consequences).

Career Development and Professionalism

1. Investigate occupational, educational, and leadership opportunities in the field of Early Childhood.
   a. Update educational, career, and leadership plans and opportunities related to children to include workforce opportunities, certifications, postsecondary educational options, and IHL educational options.
   b. Research professional organizations (NAEYC, SECA, MECA, and area child care director networks).
   c. Prepare a professional portfolio to include philosophy of early childhood education, resume, work samples, and other documentation (ex. CPAS test scores, photographs, lesson plans or activities, menus, daily schedules, observation records, etc.).
   d. Demonstrate effective job-seeking skills needed for the interviewing process.
   e. Practice appropriate behaviors in relation to individual, family, community, career, and workplace settings to include attitude, appearance, and work ethic.

f. Exemplify effective communication techniques to include clear and logical verbal and nonverbal communication, writing skills, listening skills, and speaking skills.
g. Apply leadership and team skills in the school, community, and workplace through membership and projects in FCCLA and other avenues of community service.
h. Determine the importance of demonstrating respect for individuals' differences, including sensitivity to gender, age, and cultural diversity.

The Learning Environment

1. Describe daily routines for infants, toddlers, and preschool age children in a child care setting.
   a. Discuss the importance of a daily schedule.
   b. Develop a daily time schedule for each of the following age groups: infants, toddlers, and preschoolers, who are enrolled in a child care setting, including time slots allocated for eating, napping, indoor and outdoor play, toileting, hand washing, center times, free play, transitions, and educational time.
   c. Demonstrate the use of effective transitions that could be used in a child care setting.
2. Plan a thematic unit of study.
   a. Explore program goals and factors to consider when planning a curriculum.
   b. Relate the importance of literature in the effective child care curriculum.
   c. Compile a list of developmentally appropriate themes for each of the following age groups: infants, toddlers, and preschool age children.
   d. Develop and illustrate a web or flowchart connecting activities to a themed unit of lessons.
   e. Plan and demonstrate theme based learning activities in each of the following areas: language (storytelling, writing, play, or puppetry), art, math, science, social studies, music or movement, food experiences, field trip experiences, and computer technology.
   f. Write a "block" formatted lesson plan based on a theme.
   g. Create a "daily lesson plan" to include goals, motivation or introduction, learning objectives, procedures, materials, closure/transition, and evaluation.
   h. Explore how technology is used in preschool settings.
3. Explore types of equipment and arrangement of physical space that help to promote learning.
   a. Explore factors in which room arrangement, furniture, and equipment are utilized as teaching or learning tools.
   b. Illustrate an effective way to use outdoor space and equipment to enhance learning and physical activity.
   c. Compare and contrast area child care centers in regards to facility design or layout including office, classrooms, restrooms, isolation room, rest areas, security, lighting, toys and equipment, flooring, wall and window treatments, flooring, and so forth.

Characteristics of Quality Child Care Programs

1. Explain components of quality child care programs.
   a. Investigate and outline requirements set forth by the MSDH regarding licensure of child care facilities.
   b. Research the NAEYC accreditation process.

c. Interpret goals of the Mississippi Child Care Quality Step System, a five-star rating system, developed for licensed early childhood facilities in Mississippi.
d. Examine the ITERS and ECERS rating scale system.
e. Explore the federal Head Start preschool program, curriculum, and guidelines.

Management and Administration

1. Explain the purpose of licensing and other regulations affecting child care services.
   a. Explore aspects of child care that are subject to licensing requirements, including but not limited to indoor and outdoor square footage, training or education of employees, ratio of adults to children, maximum group size, equipment, facility structure and safety, zoning codes, criminal background checks and fingerprinting of staff, health exams, and immunization status of children and staff.
2. Summarize sound business and operating procedures that are necessary for a successful, productive child care center.
   a. Identify sources of income for a program.
   b. Explore types of expenses (fixed, variable, and optional expenditures) that may be involved in operating a program, including but not limited to mortgage or rent, salaries, utilities, insurance, food, maintenance, repairs, purchasing, indoor and outdoor equipment and supplies, field trip costs, transportation, and so forth.
   c. Investigate liability and legal concerns in operating a program such as local, state, and federal regulations and laws.
   d. Explore ways to market and advertise a child care program.
3. Analyze the role of a director.
   a. Identify skills and responsibilities needed in areas of communication, leadership, management, supervision, administrative tasks such as record keeping, evaluation of staff, time management, inventory, use of technology, and networking.
   b. Outline moral and ethical characteristics stated in the NAEYC Code of Ethical Conduct and Statement of Commitment.
   c. Understand the importance of developing written rules in handbooks for parents and staff/personnel.
   d. Explore strategies to involve parents in the child care program.

POLYMER SCIENCE

Pathway Description

Polymer Science is a pathway in the Science, Technology, Engineering and Mathematics career cluster. It is an instructional program that introduces an individual to the field of plastics and polymer materials manufacturing. The program allows an individual to prepare for employment or continued education in the occupations of plastics and polymer materials manufacturing. The program is designed to provide students with hands-on experiences related to the application of polymer science concepts in the workplace. Students will develop academic and technical skills, 21st century skills, and human relations competencies that accompany technical skills for job success and lifelong learning. Students who complete the program will be better prepared to enter and succeed in related programs offered by Mississippi community and junior colleges and institutions of higher education.

Industry Certification

Two national certifications are associated with the polymer science industry. They are the **Certified Composites Technician (CCT)** and **the National Certification in Plastics (NCP).**

Articulation

At the current time, there is no postsecondary polymer science program at the community college level. Therefore, the secondary polymer science curriculum holds no articulation agreement with community colleges. However, the secondary polymer science curriculum is vertically aligned to many of the IHL requirements in the undergraduate polymer science program. The secondary curriculum is closely tied to chemistry, organic chemistry, composition, writing, problem solving, and responsibility, all of which are elements in the undergraduate curriculum for polymer science.

Assessment

Students will be assessed using the Polymer Science MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://redesign.rcu.msstate.edu/curriculum/. If there are questions regarding assessment of this program, please contact the STEM instructional design specialist at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to experience success in the Polymer Science program, the following prerequisites are recommended:

1. C or Higher in a Physical Science or Biology

   or

2. Instructor Approval

Proposed Applied Academic Credit

The Polymer Science curriculum is written to correlate with the competencies in the organic chemistry course found in the 2010 Mississippi Science Framework. The heavy academic science content prompted a request for 1/2 credit of applied science.

The applied academic credit has **not** been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

The 989 licensure endorsement is needed to teach Polymer Science. The requirements for the 989 licensure endorsement are listed below:

1. Applicant must have earned a 4-year degree (bachelor's degree) or higher from an accredited institution of higher education. The degree must be in polymer science, chemistry, or an appropriate field of science and must be approved by the MDE program coordinator.
2. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the *Redesign* Education Program (REP).
3. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
4. Applicant must successfully complete an MDE-approved computer literacy certification exam.
5. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
6. Applicant must successfully complete a Polymer Science certification workshop, module, or course that is approved by the MDE.

Note: If an applicant meets all requirements listed above, that applicant will be issued a 989 endorsement—a 5-year license. If the applicant does not meet all requirements, the applicant may be issued a 3-year endorsement (license), and all requirements must be satisfied prior to the ending date of that license.
Exception: LEAs converting to this pathway from existing programs in Plastics and Polymer Science Applications (with teachers currently licensed and endorsed #379 Plastics and Polymer Science Applications) may continue to employ those teachers and seek 989 endorsement for them although they do not meet the above stated requirement for a 4-year degree in certain major fields of study. These teachers must satisfy all other requirements stated above. All other teachers must meet the requirements for this endorsement.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at http://redesign.rcu.msstate.edu. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outline

This curriculum framework is divided into four one-Carnegie-unit courses as outlined below. The first two courses are comprised of units from Polymer Science Year 1. The last two courses are comprised of units from Polymer Science Year 2.

Option 1 – Four One-Carnegie-Unit Courses

Course Description: Introduction to Polymer Science I orients the students to the course and lab. During this course, students learn computer applications relevant to polymer science. They are also introduced to chemistry concepts and the structures and properties of polymers.

Course Description: Introduction to Polymer Science II teaches students the processing techniques associated with polymers as well as the methods and benefits of plastics recycling.

Course Description: Advanced Topics in Polymer Science is a comprehensive course that focuses on polymer synthesis, surface coatings, and composite materials.

Course Description: Careers in Polymer Science explores the job opportunities that are available for individuals in this area. The course also teaches job application and workplace skills as well as offers a potential for job shadowing.

Introduction to Polymer Science I (One Carnegie Unit) - Course Code: 994502

Unit		Title	Hours
1		Orientation and Safety	40
2		Information, Media, and Computer Applications	40
3		Introduction to Chemistry	30
4		Structure and Properties of Polymers	30
			140

Introduction to Polymer Science II (One Carnegie Unit) - Course Code: 994503

Unit		Title	Hours
5		Polymer Processing	60
6		Recycling	60
			120

Advanced Topics in Polymer Science (One Carnegie Unit) - Course Code: 994504

Unit		Title	Hours
7		Orientation and Safety Review	10
8		Polymer Synthesis	60
9		Surface Coatings	20
10		Composite Materials, Processing, and Applications	30
			120

Careers in Polymer Science (One Carnegie Unit) - Course Code: 994505

Unit		Title	Hours
11		School to Work	110
			110

Option 2 – Two Two-Carnegie-Unit Courses

Course Description: Polymer Science I orients the students to the course and lab. During this course, students learn computer applications relevant to polymer science. They are also introduced to chemistry concepts and the structures and properties of polymers. This course also teaches students the processing techniques associated with polymers as well as the methods and benefits of plastics recycling.

Course Description: Polymer Science II is a comprehensive course that focuses on polymer synthesis, surface coatings, and composite materials. This course explores the job opportunities that are available for individuals in this area. It also teaches job application and workplace skills as well as offers a potential for job shadowing.

Polymer Science I (Two Carnegie Units) - Course Code: 994500

Unit		Title	Hours
1		Orientation and Safety	40
2		Information, Media, and Computer Applications	40
3		Introduction to Chemistry	30
4		Structure and Properties of Polymers	30
5		Polymer Processing	60
6		Recycling	60
			260

Polymer Science II (Two Carnegie Units) - Course Code: 994501

Unit		Title	Hours
7		Orientation and Safety Review	10
8		Polymer Synthesis	60
9		Surface Coatings	20
10		Composite Materials, Processing, and Applications	30
11		School to Work	110
			230

Pathway Name: Polymer Science
CIP Code: 15.0607

Orientation and Safety

1. Evaluate the local program, and explore how personality traits and learning styles can impact success in the classroom and workplace.
   a. Examine the local student handbook and program, establishing rules and guidelines.
   b. Examine how understanding personality and learning styles can impact learning and workplace performance.
   c. Describe SkillsUSA activities and participate in a polymer skills competition.
2. Examine the history and development of the polymer industry/profession, to include career opportunities, earnings, and educational requirements.
   a. Trace the development of polymer technologies/ industries from beginning through present day.
   b. Describe career opportunities, including educational requirements, earning potential, and so forth for polymer-related fields.
3. Describe and demonstrate safe laboratory practices and environmental responsibility working with laboratory equipment, chemicals, and processing equipment commonly encountered in polymer-related industries.
   a. Determine how to apply safety rules/guidelines for the lab and workplace and to use safety equipment properly.
   b. Investigate how industrial, governmental, and environment organizations impact safe operations in polymer-related industries.
   c. Identify basic laboratory equipment and functions while correctly and safely using selected pieces of equipment.
   d. Detail safe practices particular to operation of equipment in polymer-related laboratories and manufacturing facilities.
   e. Evaluate resources available for safe handling and disposal of chemicals.

Information, Media, and Computer Applications

1. Demonstrate the ability to manage a computer operating system in relation to plastics and polymer applications.
   a. Create files and transfer them between directories and subdirectories.
   b. Produce and utilize graphics in relation to research for plastics design and production.
   c. Produce quality word processing documents related to polymer science topics.
   d. Create an e-portfolio to include all relevant materials.
2. Demonstrate the ability to read and interpret a basic blueprint.
   a. Demonstrate the ability to read the various parts of a blueprint.
   b. Demonstrate the ability to interpret the different views of a blueprint.
3. Apply the principles of computer assisted design and drafting (CADD) as applied to the plastics and polymer manufacturing industry.
      a. Interpret and use basic CADD symbols and terms.
      b. Apply basic CADD skills to create, edit, and print/plot 2D and 3D.
4. Apply geometry and incorporate CADD and CAM (computer-aided machining) processes into the prototype production phase of plastics and polymer manufacturing.
      a. Design a part with appropriate draft angle.

   b. Calculate and measure wall thickness.
   c. Demonstrate the importance of ribs in relation to wall thickness.
   d. Demonstrate the importance of fillets and rounds.
   e. Produce a rapid prototyped part according to specifications.

Introduction to Chemistry

1. Illustrate atomic contributions to chemical structures.
   a. Describe atomic structures to include protons, neutrons, and electrons.
   b. Demonstrate ionic and covalent bonding, including multiple bonds (double and triple).
2. Identify common organic molecules, and relate their structures to chemical and physical properties.
   a. Apply IUPAC nomenclature and illustrate structures for aliphatic, aromatic, and cyclic hydrocarbons.
   b. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons.
   c. Describe functional groups to include structures, nomenclature, and properties.
3. Investigate compositions and properties of various mixtures and conditions that impact mixture formation and stability.
   a. Define and demonstrate homogeneous and heterogeneous mixtures.
   b. Define and demonstrate various solution saturations.

Structure and Properties of Polymers

1. Relate small molecule chemistry to the production of polymers.
   a. Using models, demonstrate the structure of monomers.
   b. Using models, demonstrate the structure and synthesis of homopolymers.
   c. Using models, demonstrate the structure and synthesis of copolymers.
2. Recognize and define natural and synthetic polymers.
   a. Describe natural polymers (cellulose, DNA/RNA, natural rubber, starches, and proteins).
   b. Describe synthetic polymers (plastics, thermoplastics, thermosets, fibers, films, elastomers, and adhesives).
   c. Differentiate between properties of natural and synthetic polymers.
3. Relate rheology and viscosity to polymer properties.
   a. Research the history of rheology/viscosity.
   b. Explain the importance of rheology/viscosity.
   c. Demonstrate polymer melt rheology.
4. Explain how additives affect the properties of a polymeric material.
   a. Explain how compounding and formulation changes the properties of polymers by using additives or modifiers.

Polymer Processing and Applications

1. Explain how each manufacturing processing technique is used to convert polymer feedstock into plastic end products, participate in manufacturing plastic parts using each processing technique, and identify parts made from each thermoplastic and thermoset processes.
   a. Describe and demonstrate extrusion processes.
   b. Describe and demonstrate injection molding.

   c. Describe and demonstrate blow molding.
   d. Describe and demonstrate thermoforming/vacuum forming.
   e. Describe and demonstrate rotational molding.
   f. Describe and demonstrate casting.
   g. Describe and demonstrate expanded bead molding.
   h. Describe and demonstrate foam processing.
   i. Describe and demonstrate coatings and adhesives principles.
   j. Describe and demonstrate fiber formation.
   k. Describe and demonstrate compression molding.
2. Explain the major types of resins or materials.
   a. Identify the major types of resins: thermoplastics, thermosets, and recycled plastics.

Plastics Recycling and Conservation

1. Relate plastics recycling/conservation principles and their effects on the environment.
   a. Classify the different types of plastics and their recycle codes including PETE, HDPE, V, LDPE, PP, PS, and others.
   b. Debate the cost of using recycled polymers versus virgin polymers in manufacturing
   c. Examine issues and post-recycling uses for the different types of plastics.

Orientation and Safety (Review)

1. Evaluate the local program and explore how personality traits and learning styles can impact success in the classroom and workplace.
   a. Examine the local student handbook and program, establishing rules and guidelines.
   b. Examine how understanding personality and learning styles can impact learning and workplace performance.
2. Describe and demonstrate safe laboratory practices and environmental responsibility working with laboratory equipment, chemicals, and processing equipment commonly encountered in polymer-related industries.
   a. Determine how to apply safety rules/guidelines for the lab and workplace and to use safety equipment properly.
   b. Investigate how industrial, governmental, and environment watchdog organizations impact safe operations in polymer-related industries.
   c. Identify basic laboratory equipment and functions while correctly and safely using selected pieces of equipment.
   d. Detail safe practices particular to operation of equipment in polymer-related laboratories and manufacturing facilities.
   e. Evaluate resources available for safe handling and disposal of chemicals.

Polymer Synthesis

1. Explore how the chemistry of polymer preparation affects performance properties.
   a. Describe and demonstrate different types of polymer synthesis to include condensation and addition polymerization.
   b. Explore the effects of molecular weight and cross-linking on polymer properties.

Surface Coatings

1. Describe the production of various types of surface coatings.
   a. Describe the types of coatings, to include architectural (DIY), OEM, and specialty purpose coatings and their uses in industry.
   b. Illustrate the synthesis of surface coatings.
   c. Identify legislation that influences the push for no VOC coatings.
2. Demonstrate the properties of coatings.
   a. Demonstrate the various properties of surface coatings in relation to physical testing (i.e., blocking, scrub resistance, etc.).

Composite Materials, Processing, and Applications

1. Examine composite materials to determine how such materials affect the finish properties of a composite structure.
   a. Demonstrate composite materials and how they are utilized in composite structures.
2. Demonstrate different composite processing methods and composite applications.
   a. Demonstrate composite processes and applications and how they are utilized in composite structures.

School to Work

1. Explain and demonstrate the role human relations, teamwork, and leadership play in plastics and polymer manufacturing.
   a. Describe and practice the qualities of an effective leader including positive attitude, image, decisiveness, communication skills, and being knowledgeable.
   b. Prepare a project management methodology, and use it consistently.
   c. Research and/or participate in personal development seminars, leadership conferences, and national/international exchange programs.
2. Explain and demonstrate employability skills over the course of the program.
   a. Describe traits of a quality employee, including integrity, loyalty, responsibility, and so forth.
   b. Prepare a resume containing essential information.
   c. Complete a job application.
   d. Describe and demonstrate the procedures for a job interview.
   e. Explain personnel law, requirements of Title IX Law, and employment procedures as related to plastics and polymer materials manufacturing industry.
3. Apply skills needed to be a viable member of the workforce.
   a. Prepare a description of and demonstrate technical skills to be developed in the supervised work experience program.
   b. Demonstrate human relationship skills in the supervised work experience program.
4. Work with instructor and/or employer to develop, assess, and document performance of written occupational objectives to be accomplished during a polymer-related internship and/or simulated polymer industry.
   a. Develop and follow a set of written guidelines for the supervised work experience program.
   b. Perform written occupational objectives in the supervised work experience program.
   c. Prepare daily written assessment of accomplishment of objectives.

d. Present weekly written reports to instructor of activities performed and objectives accomplished.
e. Prepare and finalize electronic portfolio to include all relevant materials.

WELDING

Pathway Description

Welding is a pathway in the Construction and Manufacturing career cluster. It is an instructional program that prepares students for employment or continued education in occupations found in the welding profession. Students who successfully complete the welding may gain employment in a variety of businesses throughout Mississippi including ship building, petroleum pipelines, automotive manufacturing, and other metal fabrication companies. The courses in this program prepare the student for an exciting career working with various types of fusion welding techniques. Both theoretical learning and activity-based learning are provided for students who wish to develop and enhance their competencies and skills. The student will also be introduced to automated welding processes like robotic welding and frictional stir welding. The program emphasizes the techniques and tools used in a multitude of welding applications. Training on state-of-the-art equipment, like that found in metal fabrication businesses throughout the world, is an essential part of this program therefore equipment used in the courses is the same equipment found in the global work place. The comprehensive project component provides practical experience toward developing a portfolio of work.

Industry Certification

The NCCER developed and published a set of industry standards that are taught nationwide by contractors, associations, construction users, and secondary and postsecondary schools called the **Contren Learning Series.** When developing this set of standards, the NCCER assembled a team of subject matter experts that represented construction companies and schools across the nation. Each committee met several times and combined experts' knowledge and experience to finalize the set of national industry standards.

As a part of the accreditation process, all Mississippi Construction Technology instructors will be required to successfully complete the **Instructor Certification Training Program**. This program ensures that instructors possess a deep knowledge of content of the standards.

This state-of-the-art curriculum is modeled after the eight Mississippi **NCCER Accredited Training and Education Facilities (ATEF)**. In order to become an NCCER ATEF program, school districts must meet a set of guidelines including the following:

1. Use the approved curriculum.
2. All instructors must be NCCER certified.
3. All completed Form 200s and release forms on all student completions are to be forwarded to MCEF for proper approval. MCEF will in turn forward to NCCER for processing.
4. Follow NCCER guidelines on test security and performance profiles.
5. Have an active advisory committee with at least two commercial contractors involved.
6. Follow safety practices and Occupational Safety and Health Administration (OSHA) standards used in the class and lab areas.
7. Involve commercial contractors in class presentations or field trips.
8. All construction programs must be included in the accreditation process.
9. Show active involvement in student leadership development (e.g., VICA and SkillsUSA).
10. Provide demonstrated placement into construction-related occupations, and provide timely reports to MCEF.

Districts will be required to complete a self-evaluation of all programs and host a site visit from industry to ensure proper lab, safety, and instructional procedures are in place.

Articulation

The following articulation plans are in place for the Installation and Service Pathway:

High School Program	Community College Program	Community College Course
Welding	Welding and Cutting Tech Industrial Maintenance Trades	WLV 1116 - Shielded Metal Arc Welding I (effective 2006) IMM 1734 - Maintenance Welding and Metals

Assessment

Students will be assessed using the Welding MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://redesign.rcu.msstate.edu/curriculum/. If there are questions regarding assessment of this program, please contact the Construction and Manufacturing instructional design specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be successful in the Welding pathway, the following student prerequisites are in place:

1. C or higher in English (the previous year)
2. C or higher in Math (last course taken or the instructor can specify the math)

   or
3. Instructor Approval and TABE Reading Score (eighth grade or higher)

   or
4. Instructor Approval

Proposed Applied Academic Credit

Applied Math content from the curriculum was aligned to the 2007 Mississippi Math Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Math credit that can be used for graduation requirements.

The applied academic credit has ***not*** been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

A (975) educator license is required to teach the Welding pathway. Requirements for the (975) endorsements are listed below:

1. Applicant must hold a 2-year college degree (associate's degree) or higher from an accredited institution of higher education.
2. Applicant with an associate's degree must have at least 2 years of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught. Applicant with a bachelor's or higher degree must have at least 1

year of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.

3. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the *Redesign* Education Program (REP).
4. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
5. Applicant must earn a passing score on **Welding** assessment from National Craft Assessment and Certification Program.
6. Applicant must successfully complete the Contren Instructor Certification.
7. Applicant must successfully complete an MDE-approved computer literacy certification exam.
8. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
9. Applicant must successfully complete the **Welding** certification workshop, module, or course that is approved by the MDE.

Note: If the applicant meets all requirements listed above, that applicant will be issued a (975) endorsement—a 5-year license. If the applicant does not meet **all** requirements, the applicant will be issued a 3-year endorsement (license), and all requirements stated above must be satisfied prior to the ending date of that license.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at http://redesign.rcu.msstate.edu. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outline

This curriculum framework allows options for local school districts to implement based on student needs and scheduling demands. This curriculum offers a four-Carnegie-unit program.

Option 1

Upon completion of this option, the student will be trained to take the **NCCER Level 1 Core Certification and the Welding Level 1 Certification** exams. This curriculum consists of four one-credit courses, which should be completed in the following sequence:

Orientation and Cutting .....(Course Code: 993302)
Shielded Metal Arc Welding (SMAW) .....(Course Code: 993303)
Gas Metal, Flux Core, and Gas Tungsten Welding
(GMAW, FCAW, and GTAW)..... (Course Code: 993304)
Production Welding Processes..... (Course Code: 993305)

Course Description: **Orientation and Cutting** includes an introduction to the field as well as Fundamentals of Safety, Math, Blueprint Reading, Hand and Power Tools, and Oxy-fuel and Plasma Cutting Devices. This is a one-Carnegie-unit course.

Course Description: **Shielded Metal Arc Welding** emphasizes an overview of safety and shielded metal arc welding processes and equipment. This course gives students real-world, hands-on practice in these areas. This one-Carnegie-unit course should only be taken after students successfully pass Orientation and Cutting.

Course Description: **Gas Metal, Flux Core, and Gas Tungsten Welding** includes an in-depth study of the gas metal arc welding, flux core arc welding, and gas tungsten arc welding processes and equipment. This one-Carnegie-unit course should only be taken after students successfully pass Orientation and Cutting.

Course Description: **Production Welding Processes** includes an overview of Resistance Welding, Robotic Welding, Frictional Stir Welding, and Induction Welding. This one-Carnegie-unit course should only be taken after students successfully pass Orientation and Cutting and Gas Metal, Flux Core, and Gas Tungsten Welding.

- Safety will be reinforced and tested at the beginning of each course.
- Students must complete previous welding courses with a score of 80/C or higher in class work to advance to the next level.

Orientation and Cutting (Course Code: 993302)

Unit		Title	Hours
1		Orientation, Leadership, and Safety	10
2		Welding Math	15
3		Introduction to Blueprints, Hand and Power Tools, and Basic Rigging	50
4		Base Metal Preparation and Weld Quality, Oxy-fuel Cutting, Plasma Arc Cutting, and Carbon Arc Cutting	65
			140

Shielded Metal Arc Welding [SMAW] (Course Code: 993303)

Unit		Title	Hours
6		Orientation and Safety (Review and Reinforcement of Unit 1)	5
5		Shielded Metal Arc Welding (SMAW)	135
			140

Gas Metal, Flux Core, and Gas Tungsten Welding [GMAW, FCAW, and GTAW] (Course Code: 993304)

Unit		Title	Hours
6		Orientation and Safety (Review and Reinforcement of Unit 1)	5
7		Gas Metal Arc Welding (GMAW), Flux Core Arc Welding (FCAW), and Gas Tungsten Arc Welding (GTAW)	135
			140

Production Welding Processes (Course Code: 993305)

Unit		Title	Hours
6		Orientation and Safety (Review and Reinforcement of Unit 1)	5
8		Production Welding Processes	135
			140

Option 2

Upon completion of this option, the student will be trained to take the **NCCER Level 1 Core Certification and the Welding Level 1 Certification** exams. This curriculum consists of two two-credit courses, which should be completed in the following sequence:

Welding I ..... (Course Code: 993300)
Welding II ..... (Course Code: 993301)

Course Description: **Welding I** is a course in which students learn about welding technology including Math, Introduction to Blueprints, Hand and Power Tools, Orientation to the Trade, Introduction to Welding, and Shielding Metal Arc Welding. This is a two-Carnegie-unit course.

- Scheduling and operating more than one course in the same classroom/laboratory with the same instructor is not allowed.
- Safety will be reinforced and tested at the beginning of each course.

Course Description: **Welding II** is a continuation of Welding I with the emphasis on Gas Metal Arc Welding, Flux Core Arc Welding, Gas Tungsten Arc Welding, and applications of production welding processes. The course should be taken after the student has successfully passed Welding I. This is a two-Carnegie-unit course.

- Scheduling and operating more than one course in the same classroom/laboratory with the same instructor is not allowed.
- Safety will be reinforced and tested at the beginning of each course.
- Students must complete welding courses with a score of 80/C or higher in class work to advance to the next level.

Welding I (Course Code: 993300)

Unit		Title	Hours
1		Orientation, Leadership, and Safety	15
2		Welding Math	15
3		Introduction to Blueprints, Hand and Power Tools, and Basic Rigging	50
4		Base Metal Preparation and Weld Quality, Oxy-fuel Cutting, Plasma Arc Cutting, and Carbon Arc Cutting	65
5		Shielded Metal Arc Welding (SMAW)	135
			280

Welding II (Course Code: 993301)

Unit		Title	Hours
6		Orientation and Safety (Review and Reinforcement of Unit 1)	10
7		Gas Metal Arc Welding (GMAW), Flux Core Arc Welding (FCAW), and Gas Tungsten Arc Welding (GTAW)	135
8		Production Welding Processes	135
			280

Pathway Name: Welding
CIP Code: 48.0508

Orientation, Leadership, and Safety

1. Describe local program and vocational/career–technical center policies and procedures.
   a. Describe local program and vocational/career–technical center policies and procedures.
2. Describe employment opportunities and responsibilities of the welder.
   a. Describe employer expectations in the workplace.
3. Explore leadership skills and personal development opportunities.
   a. Demonstrate effective team-building and leadership skills.
   b. Demonstrate through practice appropriate work ethics.
4. Describe general safety rules for working in a shop/lab and industry.
   a. Appraise safety issues and prevention associated tools, equipment, and housekeeping found in the school shop area.
   b. Implement fire safety and prevention techniques.

Math for Welding Applications

1. Apply the four basic math skills with whole numbers, fractions, and percents.
   a. Perform mathematic calculations relating to the welding trade.
2. Perform basic mathematical calculations related to industrial maintenance shop operations.
   a. Use the metric system in craft applications.
   b. Compute distances according to a drawn plan, and then calculate the amount of material for a given project.
3. Identify and perform functions using various measuring tools and instruments.
   a. Read a ruler and layout lines to the nearest 1/16 in.
4. Read, analyze, and design a blueprint.
a. Identify and interpret terms and symbols commonly used on blueprints.
5. Demonstrate the use and maintenance of various hand and power tools found in the craft trade.
   a. Identify and discuss the proper safe use of common hand and power tools.
   b. Select and demonstrate the use of tools, and explain the procedures for maintaining hand and power tools.

Introduction to Blueprints, Hand and Power Tools, and Basic Rigging

1. Demonstrate how to read and comprehend welding blueprints.
   a. Read a basic welding blueprint found in industry and construction.
2. Identify and use tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools.

   a. Illustrate the use of tools used in the welding craft.
   b. Identify and use common hand and power tools used in the welding trade.
3. Identify and use basic rigging tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools.
   a. While identifying rigging equipment, describe how to perform safety inspections and use slings and common rigging hardware.
   b. Describe basic load-handling practices and basic hitch configurations and their proper connections.
   c. Identify basic rigging procedures, and demonstrate proper use of American National Standards Institute (ANSI) hand signals.

Base Metal Preparation and Weld Quality, Oxy-fuel Cutting, Plasma Arc Cutting, and Carbon Arc Cutting

1. Explore regulations and codes for welding, base metal cleaning, joint designs and their purpose.
   a. Discuss codes governing welding, the causes of weld imperfections, welder qualification tests, and the importance of quality of skill.
   b. Select and use a nondestructive examination practice and a destructive test method to test a student-made weld.
   c. Explain joint fit and joint measurement while fitting plate and pipe.
2. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxy-fuel welding.
   a. Identify and explain the use of oxy-fuel cutting equipment.
   b. Demonstrate how to use an oxy-fuel torch.
   c. Perform oxy-fuel cutting:
      - Straight line and square shapes
      - Piercing and slot cutting
      - Bevels
      - Washing
      - Gouging
   d. Set up and operate a motorized, portable oxy-fuel gas cutting machine.
3. Identify and describe the basic equipment, setup, use, and safety rules for proper use of equipment, and prepare base metal for plasma arc cutting.
   a. Identify and understand plasma arc cutting processes.
   b. Demonstrate how to set up and perform horizontal and vertical cuts in mild plate steel, pipe, and angled steel using a plasma torch to cut hot rolled mild steel.
4. Explore the selection, setup, and operation of carbon arc cutting equipment.
   a. Identify air carbon arc cutting processes.
   b. Demonstrate how to set up and perform washing and gouging cuts in mild plate steel, pipe, and angled steel using an air carbon arc torch to cut hot rolled mild steel.

Welding Safety and Introduction to Shielded Metal Arc Welding (SMAW)

1. Explain safety hazards, protective devices used, and how to avoid accidents that commonly occur in the welding trade.
   a. Recite safety hazards in the shielded metal arc welding shop environment.
   b. Perform safety inspection of SMAW welding equipment.
   c. Properly handle welding materials.
2. Identify types of shielded metal arc welding machines and their accessories.
   a. Explain the differences in electrical current used in welding shielded metal arc welding applications and the type of machines needed to perform the welding project.
   b. Demonstrate setting up arc welding equipment and how to use tools associated with weld cleaning.
3. Select shielded metal arc electrodes for welding applications.
   a. Explain factors that affect electrode selection, types of filler material, the ASME filler metal classification system, and how to store the filler electrodes.
   b. Properly select and weld metal using filler electrodes.
4. Setup and make beads and fillet welds.
   a. Describe the process for striking and extinguishing an arc, arc blow, and wander while properly exhibiting the process using a SMAW machine.
   b. Demonstrate stinger, weave, and overlapping beads in the horizontal, vertical, and overhead positions.
5. Set up and perform groove welds with backing and without backing.
   a. Demonstrate groove with backing and open root groove welding procedures using SMAW equipment in the flat, horizontal, vertical, and overhead positions.

Orientation and Safety (Review and Reinforcement)

1. Describe local program and vocational/career–technical center policies and procedures.
   a. Describe local program and vocational/career–technical center policies and procedures.
2. Describe employment opportunities and responsibilities of the welder.
   a. Describe employer expectations in the workplace.
3. Explore leadership skills and personal development opportunities.
   a. Demonstrate team-building and leadership skills.
   b. Demonstrate through practice appropriate work ethics.
4. Describe general safety rules for working in a shop/lab and industry.
   a. Discuss safety issues and prevention associated with the installation and service shop area.
   b. Demonstrate fire safety and prevention techniques in the workplace.

Gas Metal Arc Welding (GMAW), Flux Core Arc Welding (FCAW), and Gas Tungsten Arc Welding (GTAW)

1. Demonstrate and discuss safety procedures of, applications of, and advantages and limitations of and identify the machine controls for GMAW and FCAW.
   a. Perform safety inspections of types of GMAW and FCAW equipment and accessories available in the school shop while explaining the characteristics of welding current and power sources.
   b. Identify and explain the use of GMAW and FCAW equipment:
      - Spray transfer
      - Globular
      - Short circuiting
      - Pulse
   c. Demonstrate the ability to set up and perform GMAW/FCAW welding operations on plate:
      - GMAW-S (short-circuit) multiple-pass fillet welds in multiple positions, using solid or composite wire and shielding gas
      - GMAW-S (short-circuit) multiple-pass V-groove welds in multiple positions (with or without backing), using solid or composite wire
      - GMAW spray fillet and V-groove welds in multiple positions (with or without backing), using solid or composite wire and shielding gas
      - FCAW multiple-pass fillet welds in multiple positions, using flux cored wire and, if required, shielding gas
      - FCAW multiple pass V groove welds in multiple positions (with or without backing), using flux cored wire and, if required, shielding gas
2. Demonstrate and discuss safety procedures of, applications of, and the advantages and limitations of and identify the machine controls for the GTAW welding process.
   a. Explain the gas tungsten arc welding safety, equipment, filler metals, and shielding gases.
   b. Set up and weld using gas tungsten arc welding equipment in multiple weld positions using carbon steel filler material in the 1F, 2F, 3F, 4F, 1G, 2G, 3G, and 4G welding positions.

Production Welding Processes

1. Recognize and explain the use of resistance welding applications in mass manufacturing, and demonstrate spot welding techniques on ferrous metals.
   a. Design and manufacture a project using resistance welding.
2. Explain the use of robotics in the welding profession, and demonstrate how to safely operate welding robot equipment.
   a. Demonstrate safety procedures used in the automated environment.
   b. Describe the various major components of all robots including axis of movement, major components, and input and output devices used with robots.

   c. Demonstrate the ability to integrate a robot into a welding process by writing programs on industrial robots to perform a weld within the confines of the robot's work envelope and improve the efficiency of the robotic process by reducing cycle time, decreasing memory usage, using advanced programming techniques, and so forth.
3. Explain pipe welding, and demonstrate how to safely weld carbon steel pipe.
   a. Discuss the pipefitter career opportunities and the necessity for blueprint reading skills and math requirements of the pipefitter.
   b. Perform open-root V-groove pipe welds using SMAW, GMAW, FCAW, and/or GTAW welding processes in the following positions:
      - 1G-ROTATED
      - 2G
      - 5G
      - 6G (DOK 3)
4. Explain friction stir welding in industrial and marine applications.
   a. Discuss frictional stir welding and where it is used in everyday manufacturing processes as well as developmental processes.
5. Understand the basic concepts of induction welding and brazing.
   a. Discuss induction welding and where it is used in everyday manufacturing processes.
   b. Perform an induction weld.

Appendix A: 21st Century Skills Standards

CS 1 Flexibility and Adaptability
CS 2 Initiative and Self-Direction
CS 3 Social and Cross-Cultural Skills
CS 4 Productivity and Accountability
CS 5 Leadership and Responsibility

Today's life and work environments require far more than thinking skills and content knowledge. The ability to navigate the complex life and work environments in the globally competitive information age requires students to pay rigorous attention to developing adequate life and career skills.

CS 1 Flexibility and Adaptability

- Adapting to varied roles and responsibilities
- Working effectively in a climate of ambiguity and changing priorities

CS 2 Initiative and Self-Direction

- Monitoring one's own understanding and learning needs
- Going beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise
- Demonstrating initiative to advance skill levels toward a professional level
- Defining, prioritizing, and completing tasks without direct oversight
- Utilizing time efficiently and managing workload
- Demonstrating commitment to learning as a lifelong process

CS 3 Social and Cross-Cultural Skills

- Working appropriately and productively with others
- Leveraging the collective intelligence of groups when appropriate
- Bridging cultural differences and using differing perspectives to increase innovation and the quality of work

CS 4 Productivity and Accountability

- Setting and meeting high standards and goals for delivering quality work on time
- Demonstrating diligence and a positive work ethic (e.g., being punctual and reliable)

CS 5 Leadership and Responsibility

- Using interpersonal and problem-solving skills to influence and guide others toward a goal
- Leveraging strengths of others to accomplish a common goal
- Demonstrating integrity and ethical behavior
- Acting responsibly with the interests of the larger community in mind

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE CURRICULUM
FRAMEWORKS COMPETENCIES

Aquatic Science

AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
   g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
2. **Develop an understanding of physical and chemical properties of water and aquatic environments.**
   a. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
   b. Explain the causes and characteristics of tides. (DOK 1)
   c. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)
   d. Compare and contrast the physical and chemical parameters of dissolved O2, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
   e. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
   f. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
      - Plate tectonics
      - Rise, slope, elevation, and depth
      - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
      - Watershed formation as it relates to bodies of freshwater
   g. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
      - Barrier island, coral reef, tidal pool, and ocean
      - River, stream, lake, pond, and swamp
      - Bay, sound, estuary, and marsh

3. **Apply an understanding of the diverse organisms found in aquatic environments.**
   a. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
      - Adaptations of representative organisms for their aquatic environments
      - Relationship of organisms in food chains/webs within aquatic environments
   b. Research, calculate, and interpret population data. (DOK 2)
   c. Research and compare reproductive processes in aquatic organisms. (DOK 2)
   d. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
   e. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
   f. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
4. **Draw conclusions about the relationships between human activity and aquatic organisms.**
   a. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
      - Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
      - Effectiveness of a variety of methods of environmental management and stewardship
      - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
   b. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
   c. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
      - Careers related to aquatic science
      - Modern technology within aquatic science (e.g., mariculture and aquaculture)
      - Contributions of aquatic technology to industry and government

Biology I

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   d. Formulate questions that can be answered through research and experimental design. (DOK 3)
   e. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
   f. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   g. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

h. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
i. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. **Describe the biochemical basis of life, and explain how energy flows within and between the living systems.**
   a. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
      - Subatomic particles and arrangement in atoms
      - Importance of ions in biological processes
   b. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
   c. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
   d. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
      - Basic chemical composition of each group
      - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
      - Basic functions (e.g., energy, storage, cellular, heredity) of each group
   e. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
      - Enzyme structure
      - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
   f. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
      - ATP structure
      - ATP function
   g. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
      - Photosynthesis and respiration (reactants and products)
      - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
      - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. **Investigate and evaluate the interaction between living organisms and their environment.**
   a. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
      - Plant and animal species
      - Climate (temperature and rainfall)
      - Adaptations of organisms
   b. Provide examples to justify the interdependence among environmental elements. (DOK 2)
      - Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
      - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
      - Roles of beneficial bacteria
      - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)

c. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)

4. **Analyze and explain the structures and function of the levels of biological organization.**
   a. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
      - Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfiliaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
      - Components of mobility (e.g., cilia, flagella, pseudopodia)
   b. Differentiate between types of cellular reproduction. (DOK 1)
      - Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
      - Binary fission (e.g., budding, vegetative propagation, etc.)
      - Significance of meiosis in sexual reproduction
      - Significance of crossing over
   c. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
   d. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)

5. **Demonstrate an understanding of the molecular basis of heredity.**
   a. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
      - Structures of DNA and RNA
      - Processes of replication, transcription, and translation
      - Messenger RNA codon charts
   b. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes.) (DOK 2)
   c. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
   d. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
      - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
      - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness

6. **Demonstrate an understanding of principles that explain the diversity of life and biological evolution.**
   a. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
      - Characteristics of the six kingdoms
      - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
      - Body plans (symmetry)
      - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
      - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
   b. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)

c. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
d. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
e. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

BIOII 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOII 2	Describe and contrast the structures, functions, and chemical processes of the cell.
BIOII 3	Investigate and discuss the molecular basis of heredity.
BIOII 4	Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
BIOII 5	Develop an understanding of organism classification.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
2. **Describe and contrast the structures, functions, and chemical processes of the cell.**
   a. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
   b. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
   c. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
      - The impact of enzymatic reactions on biochemical processes
      - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
   d. Differentiate between photosynthesis and cellular respiration. (DOK 2)
      - Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
      - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
      - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
      - Oxidation and reduction reactions
3. **Investigate and discuss the molecular basis of heredity.**
   a. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
   b. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)

c. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
   - Translation of a messenger RNA strand into a protein
   - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell
   - Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
   - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)

d. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
   - Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics

e. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)

4. **Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.**

a. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
   - Main periods of the geologic timetable of earth's history
   - Roles of catastrophic and gradualistic processes in shaping planet Earth

b. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)

c. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)

d. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)

e. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)

f. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)

g. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)

h. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)

i. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)

5. **Develop an understanding of organism classification.**

a. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)

b. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)
   - Bacteria, fungi, and protists
   - Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
   - Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)

- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
BO 3 Demonstrate an understanding of plant reproduction.
BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
   g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
2. **Distinguish among the characteristics of botanical organization, structure, and function.**
   a. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
   b. Differentiate the characteristics found in various plant divisions. (DOK 2)
      - Differences and similarities of nonvascular plants
      - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
      - Major vegetative structures and their modifications in angiosperms and gymnosperms
   c. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
   d. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
      - Classification scheme used in botany
      - Classification of native Mississippi plants
   e. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
      - Relationships among photosynthesis, cellular respiration, and translocation
      - Importance of soil type and soil profiles to plant survival
      - Mechanism of water movement in plants
      - Effects of environmental conditions for plant survival
      - Tropic responses of a plant organ to a given stimulus
3. **Demonstrate an understanding of plant reproduction.**
   a. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)

b. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
c. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
   - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
   - Functions of flower parts, seeds, cones
   - Spore production in bryophytes and ferns
d. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
e. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
f. Research and compare various methods of plant propagation. (DOK 2)

4. **Draw conclusions about the factors that affect the adaptation and survival of plants.**
   a. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
   b. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)
   c. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
   d. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)
5. **Relate an understanding of plant genetics to its uses in modern living.**
   a. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
   b. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
   c. Discuss the effects of genetic engineering of plants on society. (DOK 2)
   d. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
      - Plant extracts, their function, and origin
      - Impact of the timber industry on local and national economy

Chemistry I

CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
CHI 3 Develop an understanding of the periodic table.
CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. **Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.**
   a. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
      - Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
      - Substances and mixtures
      - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
   b. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
   c. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
      - Properties and interactions of the three fundamental particles of the atom
      - Laws of conservation of mass, constant composition, definite proportions, and multiple proportions
   d. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
      - Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
      - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process
   e. Compare the properties of compounds according to their type of bonding. (DOK 1)
      - Covalent, ionic, and metallic bonding
      - Polar and nonpolar covalent bonding
      - Valence electrons and bonding atoms
   f. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)
   g. Develop a three-dimensional model of molecular structure. (DOK 2)
      - Lewis dot structures for simple molecules and ionic compounds
      - Valence shell electron pair repulsion theory (VSEPR)

3. **Develop an understanding of the periodic table.**
   a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
   b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
      - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
      - Average atomic mass calculations
      - Chemical characteristics of each region
      - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
   c. Classify chemical reactions by type. (DOK 2)
      - Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation

- Products (given reactants) or reactants (given products) for each reaction type
- Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
- Formulas and calculations of the molecular (molar) masses
- Empirical formula given the percent composition of elements
- Molecular formula given the empirical formula and molar mass

4. **Analyze the relationship between microscopic and macroscopic models of matter.**

a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
- Average atomic mass calculations
- Chemical characteristics of each region
- Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)

c. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
- Products (given reactants) or reactants (given products) for each reaction type
- Solubility rules for precipitation reactions and the activity series for single and double displacement reactions

d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
- Formulas and calculations of the molecular (molar) masses
- Empirical formula given the percent composition of elements
- Molecular formula given the empirical formula and molar mass

5. **Compare factors associated with acid/base and oxidation/reduction reactions.**

a. Analyze and explain acid/base reactions. (DOK 2)
- Properties of acids and bases, including how they affect indicators and the relative pH of the solution
- Formation of acidic and basic solutions
- Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
- The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
- How a buffer works and examples of buffer solutions

b. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)

c. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   f. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
   g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
2. **Demonstrate an understanding of the properties, structure, and function of organic compounds.**
   a. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
      - Structures of hydrocarbon compounds
      - Isomerism in hydrocarbon compounds
   b. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
   c. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
      - Lewis structures for organic molecules
      - Bond angles
      - Hybridization (as it applies to organic molecules)
   d. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
   e. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
   f. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitrides) by their structure and properties. (DOK 2)
      - Structural formulas from functional group names and vice versa
      - Chemical and physical properties of compounds containing functional groups
      - Equations representing the transformation of one functional group into another
3. **Discuss the versatility of polymers and the diverse application of organic chemicals.**
   a. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
      - Common polymers
      - Synthesis of polymers from monomers by addition or condensation
      - Condensations of plastics according to their commercial types
      - Elasticity and other polymer properties
   b. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)

- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
- Compounds that have the property to dye materials
- Petrochemical production
- Biologically active compounds in terms of functional group substrate interaction

c. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
E2 Develop an understanding of the history and evolution of the universe and earth.
E3 Discuss factors that are used to explain the geological history of earth.
E4 Demonstrate an understanding of earth systems relating to weather and climate.
E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
   g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
2. **Develop an understanding of the history and evolution of the universe and earth.**
   a. Summarize the origin and evolution of the universe. (DOK 2)
      - Big bang theory
      - Microwave background radiation
      - The Hubble constant
      - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
   b. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
   c. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in "ordinary" stars and supernovae lead to the formation of all other elements. (DOK 2)
   d. Summarize the early evolution of the earth, including the formation of Earth's solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
      - How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
      - How Earth acquired its initial oceans and atmosphere

3. **Discuss factors which are used to explain the geological history of earth.**
   a. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
      - Plate tectonic boundaries (e.g., divergent, convergent, and transform)
      - Modern and ancient geological features to each kind of plate tectonic boundary
      - Production of particular groups of igneous and metamorphic rocks and mineral resources
      - Sedimentary basins created and destroyed through time
   b. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
   c. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
   d. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
   e. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
   f. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
      - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
      - Geological timetable
   g. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
   h. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)
4. **Demonstrate an understanding of earth systems relating to weather and climate.**
   a. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
      - Latitudinal variations in solar heating
      - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
   b. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
   c. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
   d. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
   e. Research and explain how external forces affect earth's topography. (DOK 2)
      - How surface water and groundwater act as the major agents of physical and chemical weathering
      - How soil results from weathering and biological processes
      - Processes and hazards associated with both sudden and gradual mass wasting
5. **Apply an understanding of ecological factors to explain relationships between earth systems.**
   a. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
      - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
      - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
      - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)

b. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
c. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
   - Photosynthesis and the atmosphere
   - Multicellular animals and marine environments
   - Land plants and terrestrial environments
d. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
   g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)
2. **Develop an understanding of the relationship of ecological factors that affect an ecosystem.**
   a. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
   b. Explain the flow of matter and energy in ecosystems. (DOK 2)
      - Interactions between biotic and abiotic factors
      - Indigenous plants and animals and their roles in various ecosystems
      - Biogeochemical cycles within the environment
   c. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
   d. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
      - How a species adapts to its niche
      - Process of primary and secondary succession and its effects on a population
      - How changes in the environment might affect organisms
   e. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
   f. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)

g. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. **Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.**
   a. Summarize the effects of human activities on resources in the local environments. (DOK 2)
      - Sources, uses, quality, and conservation of water
      - Renewable and nonrenewable resources
      - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
   b. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)
   c. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
G 2 Analyze the structure and function of the cell and cellular organelles.
G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. **Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)**
   a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. **Review the structure and function of the cell as it applies to genetics. (L)**
   a. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
   b. Describe how organic components are integral to biochemical processes. (DOK 2)
   c. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
      - Cell cycle and mitosis
      - Meiosis, spermatogenesis, and oogenesis
   d. Explain the significance of the discovery of nucleic acids. (DOK 1)
   e. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
   f. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
   g. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. **Analyze the structure and function of DNA and RNA molecules. (L, P)**
   a. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
   b. Apply classical genetics principles to solve basic genetic problems. (DOK 2)
      - Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
      - Inheritance of autosomal and sex-linked traits
      - Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
      - Chromosomal theory of inheritance
   c. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
      - Genetic variability
      - Hardy-Weinberg formula
      - Migration and genetic drift
      - Natural selection in humans
   d. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
      - Steps in genetic engineering experiments
      - Use of restriction enzymes
      - Role of vectors in genetic research
      - Use of transformation techniques
   e. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
   f. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
   g. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
      - Safety rules and symbols
      - Proper use and care of the compound light microscope, slides, chemicals, etc.
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   b. Formulate questions that can be answered through research and experimental design. (DOK 3)
   c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
   e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
   f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
   g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. **Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.**
   a. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
   b. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
   c. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
      - Physical weathering (e.g., atmospheric, glacial, etc.)
      - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
   d. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
      - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
      - Processes that create earthquakes and volcanoes
      - Asthenosphere
   e. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
   f. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
   g. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
   h. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.) (DOK 1)
   i. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
   j. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
   k. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PS 2 Describe and explain how forces affect motion.
PS 3 Demonstrate an understanding of general properties and characteristics of waves.
PS 4 Develop an understanding of the atom.
PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**
   a. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
      - Safety symbols and safety rules in all laboratory activities
      - Proper use and care of the compound light microscope
      - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
   b. Identify questions that can be answered through scientific investigations. (DOK 3)
   c. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
      - Predicting, gathering data, drawing conclusions
      - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
      - Critically analyzing current investigations/problems using periodicals and scientific scenarios

d. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
g. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

a. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
   - Inertia and distance-time graphs to determine average speed
   - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
   - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
   - Simple harmonic motion (oscillation)

b. Explain the connection between force, work, and energy. (DOK 2)
   - Force exerted over a distance (results in work done)
   - Force-distance graph (to determine work)
   - Network on an object that contributes to change in kinetic energy (work-to-energy theorem)

c. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
d. Draw and assess conclusions about charges and electric current. (DOK 2)
   - Static/current electricity and direct current/alternating current
   - Elements in an electric circuit that are in series or parallel
   - Conductors and insulators
   - Relationship between current flowing through a resistor and voltage flowing across a resistor

e. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's Law). (DOK 2)

3. Demonstrate an understanding of general properties and characteristics of waves.

a. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
b. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
c. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
   - The emission of light by electrons when moving from higher to lower levels
   - Energy (photons as quanta of light)
   - Additive and subtractive properties of colors
   - Relationship of visible light to the color spectrum

d. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)

4. Develop an understanding of the atom.

a. Cite evidence to summarize the atomic theory. (DOK 1)
   - Models for atoms
   - Hund's rule and Aufbau process to specify the electron configuration of elements
   - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
   - Atomic orbitals (s, p, d, f) and their basic shapes

b. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
c. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
   - Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
   - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
   - Experiments (e.g., gold-foil, cathode-ray, etc.)
d. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
   - Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
   - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
   - Average atomic mass from isotopic abundance
   - Solids, liquids, and gases
   - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table

5. **Investigate and apply principles of physical and chemical changes in matter.**
   a. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
   b. Balance chemical equations. (DOK 2)
   c. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
PHYI 2 Develop an understanding of concepts related to forces and motion.
PHYI 3 Develop an understanding of concepts related to work and energy.
PHYI 4 Discuss the characteristics and properties of light and sound.
PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
PHYI 6 Analyze and explain concepts of nuclear physics.

1. **Investigate and apply principles of physical and chemical changes in matter.**
   a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
   b. Clarify research questions, and design laboratory investigations. (DOK 3)
   c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
   d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
   e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
   f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
   g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
2. **Develop an understanding of concepts related to forces and motion.**
   a. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
      - Vector and scalar quantities
      - Vector problems (solved mathematically and graphically)

- Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
- Relations among mass, inertia, and weight

b. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of freefall). (DOK 2)

c. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)

d. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)

- Situations where g is constant (falling bodies)
- Concept of centripetal acceleration undergoing uniform circular motion
- Kepler's third law
- Oscillatory motion and the mechanics of waves

3. **Develop an understanding of concepts related to work and energy.**

a. Explain and apply the conservation of energy and momentum. (DOK 2)

- Concept of work and applications
- Concept of kinetic energy, using the elementary work-energy theorem
- Concept of conservation of energy with simple examples
- Concepts of energy, work, and power (qualitatively and quantitatively)
- Principles of impulse in inelastic and elastic collisions

b. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)

c. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)

d. Investigate and summarize the principles of thermodynamics. (DOK 2)

- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
- Temperature and thermal energy as related to molecular motion and states of matter
- Problems involving specific heat and heat capacity
- First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency

e. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

4. **Discuss the characteristics and properties of light and sound.**

a. Describe and model the characteristics and properties of mechanical waves. (DOK 2)

- Simple harmonic motion
- Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
- Energy of a wave in terms of amplitude and frequency.
- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)

b. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)

c. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)

d. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)

e. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. **Apply an understanding of magnetism, electric fields, and electricity.**

a. Analyze and explain the relationship between electricity and magnetism. (DOK 2)

- Characteristics of static charge and how a static charge is generated
- Electric field, electric potential, current, voltage, and resistance as related to Ohm's law

- Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
- Coulomb's law

b. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)

c. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. **Analyze and explain concepts of nuclear physics.**

a. Analyze and explain the principles of nuclear physics. (DOK 1)

- The mass number and atomic number of the nucleus of an isotope of a given chemical element
- The conservation of mass and the conservation of charge
- Nuclear decay

b. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)

- Quantum energy and emission spectra
- Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
SP 2 Develop an understanding of geographic information systems.

1. **Demonstrate the basic concepts of global positioning systems (GPS). (E)**

a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)

b. Clarify research questions, and design laboratory investigations. (DOK 3)

c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)

e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. **Demonstrate the basic concepts of remote sensing. (E, P)**

a. Describe the characteristics of the electromagnetic spectrum.

b. Using images and graphs, interpret the absorption/reflection spectrum.

c. Distinguish between passive vs. active sensor systems.

d. Analyze the effects of changes in spatial, temporal, and spectral resolution.

e. Analyze the effects on images due to changes in scale.

f. Identify the types of sensor platforms.

Zoology

ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
ZO 2 Develop an understanding of levels of organization and animal classification.
ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**

a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

b. Formulate questions that can be answered through research and experimental design. (DOK 3)
c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. <u>Develop an understanding of levels of organization and animal classification.</u>

a. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
   - Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
   - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
b. Identify and describe characteristics of the major phyla. (DOK 1)
   - Symmetry and body plan
   - Germ layers and embryonic development
   - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
   - Locomotion and coordination
c. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
d. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
   - Phylogenic sequencing of the major phyla
   - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelmenthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
   - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. <u>Differentiate among animal life cycles, behaviors, adaptations, and relationships.</u>

a. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
b. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
   - Division of labor within a group of animals
   - Communication within animals groups
   - Degree of parental care given in animal groups
c. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
d. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
   - Terrestrial and aquatic ecosystems
   - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
   - Symbiotic relationships such as mutualism, commensalisms, and parasitism
e. Contrast food chains and food webs. (DOK 2)

4. **Demonstrate an understanding of the principles of animal genetic diversity and evolution.**
   a. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
      - Relationship between natural selection and evolution
      - Mutations, crossing over, non-disjunction
      - Nonrandom mating, migration, etc.
      - Effects of genetic drift on evolution
   b. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then, this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first, afterward, in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore, however, in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).

- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.
- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for, appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.

- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.

- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3 Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4 Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.

- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90°, 180°, and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30°-60°-90°, 45°-45°-90°, similar, and congruent triangles.
- Use the Pythagorean theorem.

- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7 Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.

- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.

- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
  - Acknowledging counterarguments to the writer's position
  - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
  - Partially evaluating implications and/or complications of the issue
  - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
  - Examining different perspectives
  - Evaluating implications or complications of the issue
  - Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
  - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
  - Using simple vocabulary
  - Using simple sentence structure
  - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
  - Using simple but appropriate vocabulary
  - Using a little sentence variety, though most sentences are simple in structure
  - Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
  - Using appropriate vocabulary
  - Using some varied kinds of sentence structures to vary pace
  - Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
  - Using some precise and varied vocabulary
  - Using several kinds of sentence structures to vary pace and to support meaning
  - Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
  - Using precise and varied vocabulary
  - Using a variety of kinds of sentence structures to vary pace and to support meaning